

An aerial photograph of a building under construction, featuring a corrugated metal roof and wooden framing. A large, bright yellow arrow points from the top left towards the building. The entire image has a red color overlay.

FENIX 2.0

TEAM CHILE / USM

JURY NARRATIVES
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**U.S. DEPARTMENT OF ENERGY
SOLAR DECATHLON 2020**
Architecture Jury Narrative

Team Chile is participating in the Solar Decathlon 2020 [1] with a solar-powered representative dwelling called "Casa FENIX 2.0", a single-family unit of mixed-use multifamily and multi income development that is innovative, cost-effective, and energy-efficient. Casa FENIX 2.0 starts from the "Metamorphosis" concept, which sees housing as a process that adjusts to the family life cycle and changes of family profiles, fostering high flexibility by continuous architectural transformability from an early stage of design. Originally, Team Chile's approach was to target urban infill issues with solar housing development. However, faithful to its resilient philosophy, our current prototype has adapted to respond to a post-disaster reconstruction after a devastating fire last December in Valparaíso, Chile. This version FENIX 2.0 will be the Uribe-Troncoso family home as part of the reconstruction program of the Ministry of Housing and Planning, MIN-VU, through the subsidy given by Housing and Planning Regional Authority, SERVIU of Valparaíso. The present project will continue later to build more FENIX 2.0 as a triplex and small residential clusters for the reconstruction of 245 lost homes.

Introduction

Team Chile UTFSM has designed, is still building, and will operate a solar-powered dwelling called "Casa FENIX 2.0" (For Emergency post-Natural Impact eXtreme) to participate in the Solar Decathlon 2020 Competition. Aligned with its original premise of design flexibility -- as in its predecessor "Casa Metamorfosis" -- Casa FENIX has undergone a continuous design transmutation since the beginning of SD2020, which has been revised even further due to the Covid19 pandemic and the latest big fire in Valparaíso on December 2019.

The dwelling is a single-family unit of a mixed use - multifamily and multi income (MM+M) - that is innovative, cost-effective, and energy efficient, to be occupied by a victim family from the December 2019 fire of Valparaíso; sponsored by the regional housing authority SERVIU through a reconstruction subsidy from MINVU.

Team Chile's idea was originally to target urban infill issues with a solar MM+M development. Our proposal was meant to understand Chilean housing from the current family profile perspective, without stigmas or a negative sense of belonging. To address these issues, we originally took an existing housing problem in Santiago of Chile to inform the design and groundwork of the proposal: Most cities in Chile are facing gentrification. The social inequality and contrast between consolidated and non-consolidated communities are evident in terms of connectivity and services, causing low-income families to migrate to neighborhoods with a lower quality of life in order to escape the rising costs of housing. In this scenario, a group of inhabitants from Ñuñoa (Santiago) inspired the previous version of Casa FENIX 2.0 called Casa Metamorfosis where the premise was: "We do not want to stop living in the place that saw us grow" [2].

The original proposal, Casa Metamorfosis, has undergone a major adapting process becoming "Casa FENIX 2.0". This updated program departed within the above-mentioned social housing issue and became a real-world response to a real housing need from a family victim of a massive fire in Valparaíso. The event affected three hills of the 42 hills of Valparaíso, leaving 245 families homeless, who are still living under a temporary rental subsidy, waiting for their new homes, which has been postponed due to the COVID19 pandemic period.

This fire was just one of many catastrophes that Chile and the world have experienced due to global climate change. After this dreadful incident, the social inequality and contrast between consolidated and non-consolidated communities are evident in terms of connectivity and services. This caused low-income families to migrate to neighborhoods and outskirts of cities with a lower quality of life in order to escape the rising costs of housing.

Team Chile's approach regarding innovation has focused on two major technical aspects, building materials and building construction. As we are in a timber-producer nation, Casa FENIX 2.0 will be built in wood as the main construction material, offering an alternative to the extremely traditional housing industry -typically based on reinforced concrete structure with masonry infill; a good solution for a highly seismic country. Also, the prefabricated and industrialized method will rely on Timber Joinery Robotics (CAR) [3], which indeed is a very innovative and attractive way for timber construction in Chile, not even explored in our country yet.

DESIGN PHILOSOPHY AND HOUSE DESIGN

The proposal of "Casa FENIX 2.0" is based on the premise that MM+M housing schemes are socially, environmentally and economically sustainable. This translated into a housing proposal able to adapt to different lifestyles and different stages of the occupant's lifecycle and be responsive to the natural program obsolescence by changing over time. Current global and local contingencies, as the Valparaíso fire and the Covid19 Pandemic, have been critical to test the resilience and capacity for adaptation of the FENIX 2.0 proposal. In this section, we introduce the main background concepts that were included as part of the design process.

The Metamorphosis Concept

Departing from the Habraken's question: Why do people change their houses? [4] The team addressed this issue from our Chilean perspective by identifying various factors, such as the need for identity, the changes in lifestyle and changes of family profiles, the recurrent natural catastrophes, and the new technological possibilities. One of the most important factors that drive the need for spatial changes is the transformation on family profile along with the increase in life expectations. Chilean families used to be highly traditional. Yet, current Chilean families have similar features than OECD countries [5]. Thus, throughout our lives, we vary the way we relate to friends, neighbors, and family members. In addition, based on modern IT trends and developments, Chilean families have established new ways of working from home, which have pushed the need for home-space adaptation even further. Accordingly, to think of housing as a process that adapts to the family life cycle and changes of family profiles requires high flexibility at an early stage of design.

Our flexible design approach begins with a basic set of units of various square footages, as first residents require, which are enclosed in a regular structural grid. Then, after a first stage of spatial arrangements and allowed by the flexible nature of the structural components, future spatial variations are still possible, given agreement and coordination among different occupants. The variations must respond to the needs of occupants regarding space addition, reduction, partition, as well as special equipment allocation. For our project, the design of these first set of variations started originally and collaboratively with the Ñuñoa Housing Committee and their inhabitants. To establish a limited set of variations and reconfigurations, the team has identified real-life situations from the prospective residents of Casa FENIX 2.0 proposal.

The Chilean Housing Problem

The main Chilean metropolis, Santiago, underwent a rapid urban expansion between 1959 and 1979, beginning with a process of social segregation with the displacement of high-income sectors from the center to the eastern sector, and the establishment of low-income sectors towards the periphery, north, west and south of Santiago. In this way, the city is stratified and zoned into very distinctive social classes, with the consequent problems of social coexistence. Casa FENIX 2.0 site was originally in Ñuñoa county, which portrays the upper and upper middle-income sector. In Ñuñoa, it is possible to identify smaller spots of areas that are the most gentrified zones within metropolitan Santiago. Sepulveda [6] states that from the colonial period onward the city has tended to eradicate –or hide away– those aspects of cities that are unpleasant –such as the sight of poverty with squatters– pushing them to the periphery. All these considerations are still current at the new location of Casa FENIX 2.0 in Valparaíso.



Figure 1: Ñuñoa "Casa Metamorfosis" original project. Source: TeamChile

As its name indicated, the "Casa Metamorfosis" project consisted of a set of apartments, which interiors can be modified in their shape, surface, volume, solar orientation, natural ventilation, accessibility, function and other qualities. All this, through wooden frameworks and prefabricated panels, which are manually removed and which do not compromise the integrity of the structure.



Figure 2: Interior Render "Casa Metamorfosis" original project. Source: TeamChile

Being Chile a highly seismic country, timber high-rise construction appears as not a viable solution, mainly due to the little knowledge of engineering wood and its technical potentials, besides, regulations in timber building construction are precarious. Thus, Casa FENIX 2.0 proposed to advance in this aspect through the development of posts and beams structural system for medium-rise building, based on engineering wood manufactured with robotic processes, which we have denominated Robot Assisted Carpentry (RAC corresponds to CAR, 'Carpintería de Armar Robotizada', in Spanish), being this an innovation for our country.

The Definite Site and Climate

Valparaíso (33°03S, 71°37W) is a major city, seaport, naval base and educational center in the county of Valparaíso, Chile and has a mild Mediterranean climate [7]. It has north orientation and it is regulated by a temperature-stable Pacific ocean. Valparaíso is one of those rare regions where designing climate-passive architecture is still possible. By having an appropriate design, orientation, quality of envelopes, light management and intelligent use of local energies, comfortable spaces are achievable without having active-energy strategies or external energy sources [8].

Valparaíso presents interesting temperature charts since it does not record any temperature below zero in 40 years. The maximum temperature recorded is 35 ° C. Furthermore, due to its situation in front of the sea, Valparaíso is a humid city. However, for the annual average temperatures it is quite comfortable around noon, even considering the whole year dawns are commonly highly humid.

In Valparaíso, the high average pressures are concentrated between June and September, corresponding with the rainiest and coldest periods, which also coincide with the highest relative humidity. The rains in Valparaíso are concentrated in the May-August period, although in the 40 years registered, rains are observed every month of the year. It is noted here that these observations also contemplate the minimum contributions of low fogs in the bay area [8].

Finally, Casa FENIX 2.0 found a family that urgently needed it. After trying several possibilities to situate the prototype, the latest actions and decision of the allocation of SD 2020 Casa FENIX 2.0 was taken in early 2020 when the Covid19 pandemic period was starting in Chile. For it, Team Chile and SERVIU analyzed the 245 family profiles and property locations, met with some of the victims and decided to grant the Uribe-Troncoso family on Rocuant Hill with Casa FENIX 2.0, the first reconstruction subsidy after the aforementioned fire.

The opportunity of building a prototype for a family that was victim of a fire disaster arises from our first participation in the Solar Decathlon, Europe 2014. After SD2014, it was possible to build the FENIX 1.0 House for another family, which had been the victim of the great fire of the hills of Valparaíso in April 2014. In this fire, 3,000 families and 14,000 people were left homeless. Then, the FENIX HC House was a replica of the competing house of the SD2014 in France and was built with a housing subsidy to reconstruct houses affected by the fire. Now, the objective is to be able to improve this methodology, continue applying it, and add a sustainable housing typology to the ones that exist today in our market. A year ago, at the first term of 2020, one of the Advanced Architecture studios of the UTFSM architecture department worked on the design of the remaining homes, based on the principles that were established for the design of Casa FENIX 2.0.]

Figure 3: Selection of unit to be built as a prototype. Source: TeamChile



UNIQUE HOUSE FEATURES

Casa FENIX 2.0, Sustainable Flex-Design

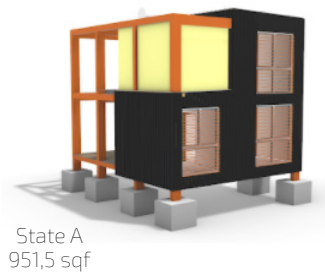


Figure 4: Square foot transformations.
Source: TeamChile

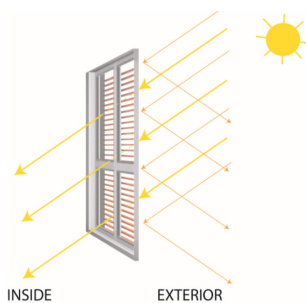
Casa FENIX 2.0 proposes flexible unit typologies according to the occupant's family composition, which responds to the current lifestyle of Chilean families. These families are dynamic and diverse, and through their changeability over time, they can inform and support the metamorphosis essence of our proposal. This metamorphosis is manifested through the over-time transformation of the dwellings by means of flexible spaces that vary their shapes, orientation and even their layouts by modifying the adjacent housing units. Thus, the main characteristics of Casa FENIX 2.0, consists of the possibility of space transformations through the extraction of walls and / or slabs of the housing units. To support this method, the construction approach is designed in such a way that the primary and secondary structural subsystems work together to form an integrated product.

The wood structure is projected by a glued-laminated posts and beams system constituting a reticle, inscribed within a mesh that modulates the operations of spatial variations, allowing growth up until 1195,8 sqf as we can see in the figure 4.

As a secondary structure, there are adaptable walls, which are mostly in the perimeter of the first floor, wet zone, and some walls of the facade. These walls are called "adaptable" because despite being fixed in the structure, their openings are reconfigurable, which allows a change at the spatial level of each housing unit.

Finally, the removable walls (non-structural), which adapt differently according to the type of wall they are linked to. These walls are partition walls and easy to move around so that families can change and reconfigure the spaces as they see fit within the transformable zone. The project takes flexibility as its design concept that is manifested through a master plan for the entire block by understanding the context. New areas and uses different from those in the sector and anticipating the times, contemplating diversity of users as well.

Energy Efficiency by Design



Team Chile focuses on avoiding power bills for the inhabitants and achieving energy performance by using an efficient architectural design, and solar energy to provide electricity for all appliances, lighting as well as the HVAC system. The expected energy balance is Zero.

The overall design has a compact building shape and simple geometry with an optimal solar orientation, providing solar protection for North (southern hemisphere), East and West fenestrations (figure 5). A high efficiency-building envelope is proposed to preserve heat by means of a thermal enclosure that minimizes the losses by conduction and air infiltrations. This avoids dark corners and ensures the entry of natural light at any time of the day, allowing any type of activity to be carried out.

Figure 5: Sunlight inputs. Source: TeamChile



Figure 6-7: Vapor, air, and water paper barriers. Source: TeamChile

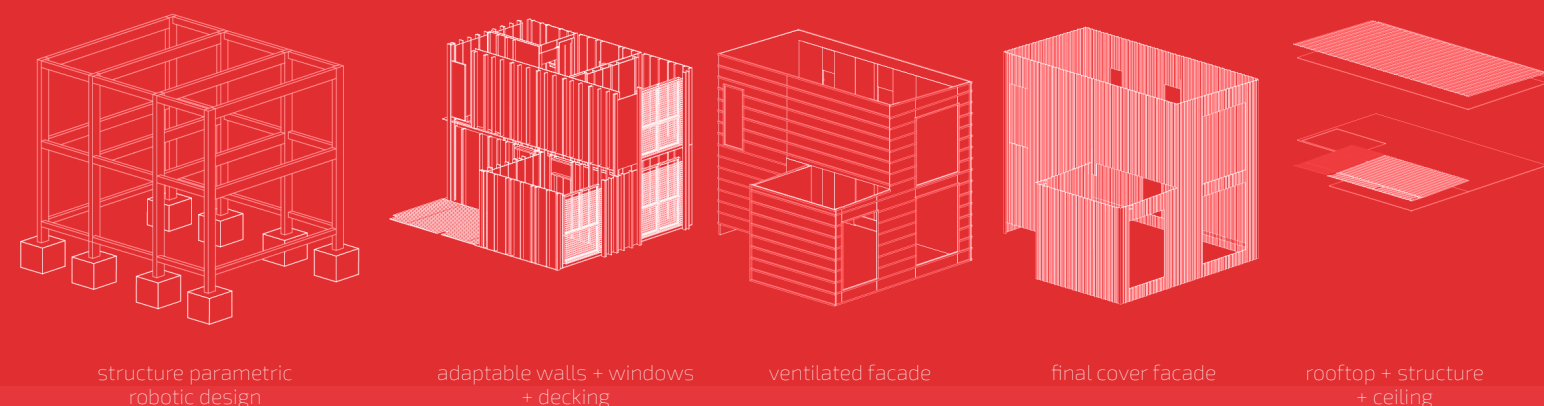
The envelope is based on several layers of wood insulation. Vapor, air, and water paper barriers will be installed for airtightness and humidity control. To avoid overheating, the exterior-most layer will be ventilated, while the interior layers are set to increase admittance for thermal mass. The floor will be also finished with wooden laminate flooring to increase thermal inertia and decrease sound transmission.

For the indoor air quality, humidity and temperature control will be addressed from ventilation and wind patterns, using a seasonal mixed ventilation program, and complemented with natural ventilation in autumn and spring. Using mechanical hybrid ventilation for winter and summer, avoiding thermal losses using a mechanical fan with heat recovery will be installed.

Metamorfactoring

The Casa FENIX 2.0 dwelling develops a novel transformable building system, which is not only fully made of timber structure and skins, but also innovates on mid-height timber structures for housing in Chile from its manufacturing approach. The proposal uses engineered wood and a structural approach based on robotic carpentry and complex-geometry joints. The 5x5m wooden grid is industrially manufactured through robotic parametric design (Timber Joinery Robotics) composed of linear components of glulam timber with robotically carved out joints. We use the high-precision and high-replicable approaches of robotic manufacturing to enhance the opportunities of wooden structures in modern architecture. In the end, all these parts of the construction system generate a reduction in the total cost of construction, thanks to time savings, minimal need for heavy machinery and reduced professional labor during the construction process (See Fig 8).

Figure 8: Axonometric operated main parts of the prototype; Source: Team Chile



Simple Geometry - Simple Zoning

The house is divided in four large zones as shown in figure 9 below, the vertical circulation area in magenta, active area for multiple activities (dedicated to family gatherings, meeting point, food area and group activities) in dark green, passive area (dedicated to rest and meditation) in peach and the humid zone in blue, which concentrates the installations of drinking water, gray water and sewage system, also connected to the water recycling and fire mitigation system, SURG.

Sunlight and Views

The main fenestrations with bigger surfaces of the house are made of double-paned windows facing North, they are sound-proof and allows optimal conditions for thermal comfort and wind protection, Fix shading devices are considered to prevent excessive radiation, however they do have a great sunlight exposure and a panoramic view of the Pacific Ocean and the hills of Valparaíso, from the main zones of the house. Given these North facing windows need to be seismic-proof, an additional reinforcement of a 75x75x3 mm beam-handle at 950 mm from the floor was designed to comply with the code.

Figure 9: Areas of Activity; Source: Team Chile





From our previous experiences of participatory design of Casa Metamorfosis (2018) and FENIX HC (2014), Team Chile originally focused the proposal on a community affected by gentrification. Then, as the project evolved, a devastating urban fire in Valparaíso that affected 128 low-income families became our new objective. In a country marked by social and natural disasters, the resilience factor becomes an opportunity for reconstruction after any of these catastrophic and recurrent events that affect the most vulnerable sector of our society. The reconstruction of houses after a disaster that has affected any poor sector of our society is normally assumed by the government. Therefore, the housing authority demands creative and fast solutions to house the people that have become homeless. Our local housing authority, SERVIU, knew well about our past and current participation in SD and invited Team Chile to use the new and revised version of Casa FENIX 2.0 to build the first reconstruction home after this last event. Consequently, Team Chile agreed and took this new challenge of demonstrating that solar and energy efficiency features must be part of social housing, by providing an affordable, creative and innovative solar home, to be financed with the available housing subsidy for reconstruction with the further agreement of converting this project in a timber social housing typology, and build triplex and duplex in the near future. After a year of a severe catastrophic pandemic period that is ventilating the most crude reality of the inequalities of our nations, projects like Casa FENIX 2.0 become an opportunity for the re-thinking of social housing in Chile.

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